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(54) PNEUMATIC POWER UNITS USING REVAPORISED LIQUEFIED GAS

(71) We, COAL INDUSTRY (PATENTS) LIMITED, a company organised in accordance with the laws of Great Britain, of Hobart House, Grosvenor Place, London, SW1 7AE, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pneumatic power units employing revaporised liquefied-gas.

In particular, although not exclusively, the present invention relates to portable power units which use revaporised liquefied-nitrogen.

It is known for a liquefied-nitrogen drive to comprise a pressurised insulated vessel for liquefied-nitrogen and a boiler device for converting liquefied-nitrogen to gas, the boiler device being fed with liquefied-nitrogen from the vessel. In such a previously known drive the vessel was pressurised by allowing uncontrolled leakage of heat through the vessel's insulation which induced the liquefied-nitrogen to boil. Unfortunately, such a drive tended to take a long time to build up to an operational pressure especially if the drive was situated in a low temperature atmosphere.

One object of the present invention is to provide a pneumatic power unit which is portable and quickly ready for operation and which can be selectively connected to a range of driven implements, for example, percussive picks or rotary tools.

According to the present invention a pneumatic power unit comprises a protecting and supporting framework, an insulated sealed vessel for containing liquefied-gas mounted within the framework, pressurising means for pressurising the liquefied gas within the vessel, a boiler device for revaporising liquefied gas discharged from the vessel by the pressure provided by the pressurising means, a valve connector for attachment to supply a pneumatically driven implement, the boiler device feeding the revaporised gas to the valve connector, and a fan for inducing a flow of heating gas through the boiler, the fan being actuated by revaporised gas from the boiler device.

Preferably, the pressurising means comprises a further boiler device for revaporising liquefied gas from the vessel.

Conveniently, the further boiler device is fed with liquefied gas induced to flow from the vessel by the action of gravity.

Preferably, the power unit comprises indicator means for sensing and indicating the amount of liquefied gas in the vessel.

Advantageously, the indicator means comprises a gas expansion pad between the framework and the vessel for lifting the vessel from the framework, a passageway connected to the pad for supplying gas to the pad and pressure measuring means for indicating changes in pressure in the passageway.

Advantageously, the vessel is provided with a removable filling-cap which cannot be removed while the vessel is pressurised.

Preferably, the vessel is provided with at least one relief valve and a bursting disc to limit maximum pressure in the vessel.

Preferably, further relief valves are associated with the boiler devices, respectively.

Conveniently, the framework includes a casing arranged to temporarily contain any intermittent leakage of liquefied-gas from the power unit.

By way of example only, one embodiment of the present invention will be described with reference to the accompanying drawings in which:—

Figure 1 is a circuit diagram of a pneumatic power unit constructed in accordance with the present invention; and

Figure 2 is a diagrammatic view of a detail of the power unit.

Referring to Figure 1, the pneumatic power unit comprises an insulated vessel 1 for containing liquefied-gas, for example liquefied-nitrogen, the vessel being mounted within and insulated from a protecting and supporting framework 2 (see Figure 2). First passage means including lines 4 and 5 feed liquefied-nitrogen from the vessel, the line

4 feeding liquefied-nitrogen via a stop valve 6 to a coil 8 of a boiler device 7 for converting liquefied-nitrogen to gaseous-nitrogen and i.e. revaporising liquefied nitrogen and the line 5 feeding liquefied-nitrogen to a further boiler device 9 for converting liquefied-nitrogen to gaseous-nitrogen i.e. revaporising liquefied nitrogen and discussed later in this specification. In the boiler devices 7 and 9 liquefied-nitrogen absorbs heat from the atmosphere, boils, then passes from the devices as gaseous-nitrogen.

The line 4 and the coil 8 are arranged below the normal operating level of the liquefied-nitrogen in the vessel 1 so that liquefied-nitrogen is induced to flow by the action of gravity into the coil 8 along line 4.

Second passage means including lines 10 and 11 are provided for feeding gaseous-nitrogen to the vessel 1 from the boiler device 7 and for feeding gaseous-nitrogen to an exhaust valve 13 and to pressure gauge 14, bursting disc 15 and pressure relief valves 16 and 17. The valve 13 is for releasing pressure when desired.

A pressure relief valve 20 is provided in the line 10.

The line 5 feeds liquefied-nitrogen to the boiler device 9 via a stop valve 21 to a coil 22 through which an air flow is induced by a fan 25 actuated by gaseous-nitrogen flowing via line 26 and stop valve 27 from line 28 leaving the boiler device 9. The valve 27 may be a control valve sensitive to the temperature in the line 28 and controlling the flow of gas to actuate the fan to maintain the temperature in line 28 within a preselected range. Thus, if the sensed temperature in line 28 falls below a preselected value then more gaseous-nitrogen is allowed to flow along line 26 causing the fan to run faster and induce a larger air flow through the boiler device 9. Hence, more heat is absorbed from the air flow and the temperature in line 28 increases.

Gaseous-nitrogen from the boiler device 9 passes along line 28 via a stop valve 30 to a bank of valve connectors 31, 32 and 33 for attachment to supply lines of pneumatically driven implements. A pressure gauge 35 and pressure relief valves 36 and 37 are provided in the line 28.

The first passage means also provides a line 40 branching from the line 5 to a tap connector 41 for facilitating the supply of pressurised liquefied-nitrogen for other purposes.

Figure 2 shows an arrangement for sensing the amount of liquefied-nitrogen in the vessel 1 which as previously mentioned is mounted within the framework 2. The arrangement includes a line 50 for feeding gaseous-nitrogen from line 11 of the second passage means via a reducing valve 51 and an indicating gauge 52 to a gas-containing load cell 53 located under the vessel 1 to sense the weight and, therefore, the liquefied-gas content of the vessel. The reducing valve 51 is adjusted until the downstream pressure no longer increases. This corresponds to the vessel 1 being just lifted from its mounting 55. Thus, the pressure gives an indication of the amount of liquefied-gas currently in the vessel.

In other embodiments of the invention, the arrangement illustrated in Figure 2 may be replaced by other means for sensing the amount of liquefied-gas in the vessel, for example, an internal float mechanism arranged to sense the level of the liquefied-gas in the vessel.

The framework 2 is provided with a casing 60 arranged around the pneumatic system of the power unit to provide limited protection for the system and to temporarily contain any intermittent leakage of liquefied-nitrogen from the power unit. Any leakage thus is restrained allowing harmless evaporation into the atmosphere.

A removable filling cap 61 for the vessel 1 is provided, the cap being mounted in the vessel such that it cannot be removed if the vessel is pressurised.

In use, the cap 61 is removed from the exhausted vessel 1 which is then filled with liquefied-nitrogen up to a preselected level. The cap is then replaced and the valve 6 opened so that liquefied-nitrogen is induced to flow by action of gravity into the coil 8 of the boiler device 7, the line 4 and at least the input of the coil 8 being arranged below the level of liquefied-nitrogen in the vessel 1. As soon as liquefied-nitrogen reaches the boiler device 7 it starts to absorb heat from the atmosphere surrounding the coil 8 and quickly boils to derive gaseous-nitrogen which is fed to the vessel 1 via line 10 increasing the pressure in the vessel. When the pressure in vessel 1 has reached a preselected value indicated by pressure gauge 14 the stop valve 21 is opened to allow liquefied-nitrogen to be moved along line 5 under the action of pressure existing in the vessel to the boiler device 9 where the liquefied-nitrogen absorbs more heat from the atmosphere surrounding the coil 22 and boils. The resultant formed gaseous-nitrogen is passed along lines 28 and 26 (the valve 27 being open) to actuate the fan. Hence, an air flow is induced through the boiler device 9 giving rise to a greater production of gaseous-nitrogen which is fed via the opened valve 30 to the valve connectors 31, 32 and 33.

Thus, supply lines of one or more pnuematically driven implements can be coupled to the valve connectors to receive pressurised gaseous-nitrogen.

From the above description it can be seen that the present invention provides a pneu-

matic power unit which lends itself to being portable and which can be transported to various sites to provide a rapid source of pneumatic power. Such a power unit is particularly useful where strict conditions exist on the use of electrical power, as for example, in an underground coal mine, or anywhere a potentially explosive atmosphere may exist.

In other embodiments of the invention the pressurising means comprises a gas pump or an internal heating element which may be activated by electricity or hot fluid.

In other embodiments of the invention a receiver is provided to store gas fed from the boiler device 9.

WHAT WE CLAIM IS: —

1. A pneumatic power unit comprising a protecting and support framework, an insulated sealed vessel for containing liquefied gas mounted within the framework, pressurising means for pressurising the liquefied gas within the vessel, a boiler device for revaporising liquefied gas discharged from the vessel by the pressure provided by the pressuring means, a valve connector for attachment to supply a pneumatically driven implement, the boiler device feeding the revaporised gas to the valve connector, and a fan for inducing a flow of heating gas through the boiler, the fan being actuated by revaporised gas from the boiler device.

2. A unit as claimed in claim 1, in which the pressurising means comprises a further boiler device for revaporising liquefied gas from the vessel.

3. A unit as claimed in claim 2, in which the further boiler device is fed with liquefied gas induced to flow from the vessel by the action of gravity.

4. A unit as claimed in any one of the preceding claims, in which the power unit comprises indicator means for sensing and indicating the amount of liquefied gas in the vessel.

5. A unit as claimed in claim 4, in which the indicator means comprises a gas expansion pad between the framework and the vessel for lifting the vessel from the framework, a passageway connected to the pad for supplying gas to the pad and pressure measuring means for indicating changes in pressure in the passageway.

6. A unit as claimed in any one of the preceding claims, in which the vessel is provided with a removable filling-cap which cannot be removed while vessel is pressurised.

7. A unit as claimed in any one of the preceding clamis, in which the vessel is provided with at least one relief valve and a bursting disc to limit maximum pressure in the vessel.

8. A unit as claimed in claim 8 when dependent upon claim 2, in which further relief valves are associated with the boiler devices, respectively.

9. A unit as claimed in any one of the preceding claims, in which the framework includes a casing arranged to temporarily contain any intermittent leakage of liquefied gas from the power unit.

10. A pneumatic power unit substantially as described herein with reference to Figures 1 and 2 of the accompanying drawings.

For the Applicants:
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1458560 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

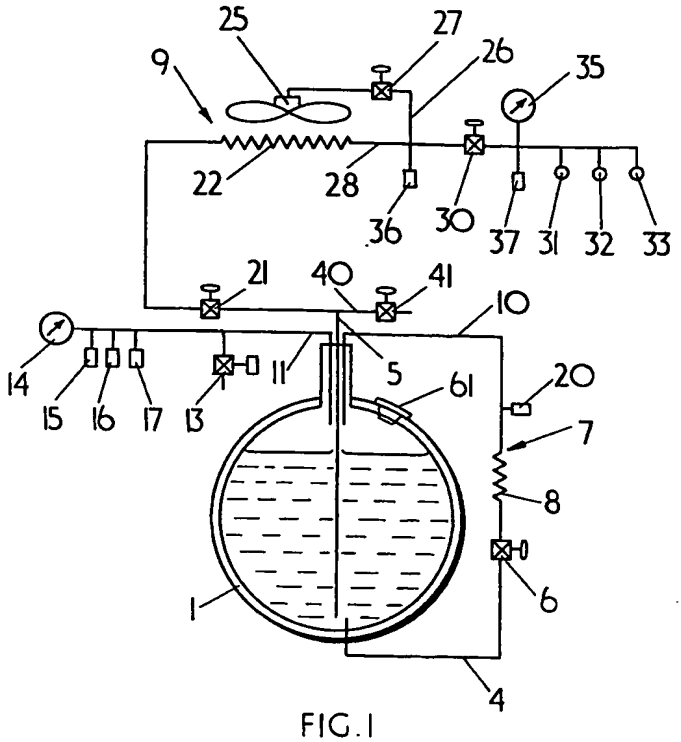

FIG. 1

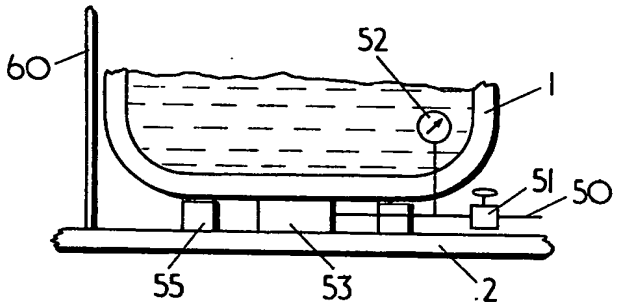

FIG. 2